

Appl. No : 10/060,483
Amdt. dated : 09/30/03
Reply to Office Action of 09/08/03

REMARKS/ARGUMENTS

Examiner Hoa B. Trinh is thanked for thoroughly reviewing the subject application. All claims are believed to be in condition for allowance.

Specification

Reconsideration of the objection to the specification is respectfully requested based on the following.

The title of the invention has been amended, replacing it with the following title which closely resembles the title as kindly suggested by Examiner: METHOD FOR IMPROVING BUMP RELIABILITY FOR FLIP CHIP DEVICES.

The specification has further been carefully reviewed and amended to correct editorial problems, in addition to others. The specification is now believed to be in acceptable condition.

Claims 12 and 26 have been amended so that these claims are now specified more precisely and without ambiguity.

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In light of the foregoing response, applicant respectfully requests that the Examiner's objection to the specification be withdrawn.

Claim rejections - 35 U.S.C. § 112

Reconsideration of the rejection of claims 7, 12 and 24 under 35 U.S.C. 112 is respectfully requested based on the following.

The Examiner is thanked for pointing out the various antecedent problems in the claims. The claims have been carefully reviewed and amended to correct those problems the Examiner pointed out, in addition to others. All claims are now believed to be in allowable condition.

In light of the foregoing response, applicant respectfully requests that the Examiner's claim rejection of claims 7, 12 and 24 under 35 U.S.C. 112, be withdrawn.

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Claim rejections - 35 U.S.C. § 102

Reconsideration of the rejection of claims 1-11, 13-25, 27-28 under 35 U.S.C. 102(e) as being anticipated by Huang (U.S. Patent 6,452,270 B1) is respectfully requested based on the following.

Huang provides for a semiconductor device having a bump electrode. More specifically, Huang provides for a compound layer of UBM over which a solder bump is created. The compound nature of the UBM layer provided by Huang is specifically created to enhance adhesion between the UBM and the passivation layer (provided by a titanium layer) and to provide improved electrical performance (a copper layer that is in direct contact with a copper contact pad).

Huang specifically does not provide for, as specified in for instance amended claim 1 of the claimed invention, which specifies a method to create a solder bump for interconnection of flip chip devices, which is quoted following with underlined aspects of the claim 1 specification that highlight provisions

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of the claimed invention that are not provided by Huang, as
follow:

- providing a substrate with at least one contact pad exposed through a patterned layer of passivation, a layer of Under-Bump-Metallurgy (UBM) having been deposited
- creating at least one T-shaped layer of solder compound over said layer of UBM in at least one opening created in a layer of patterning material, the at least one T-shaped layer of solder compound being aligned with the at least one contact pad having been provided over the substrate, the creating at least one T-shaped layer of solder compound over the layer of UBM comprising:
 - (i) depositing the layer of patterning material over the layer of UBM; and
 - (ii) patterning and developing the layer of patterning material using a grey-tone mask
- removing the layer of patterning material, leaving in place said at least one T-shaped layer of solder compound, exposing said layer of UBM
- etching the exposed layer of UBM using the at least one T-shaped layer of solder compound as a mask, and
- reflowing said solder compound, creating said solder bump.

Because Huang does not provide for that above underlined provisions of the claimed invention, Huang differs in the following key aspects and advantages of the claimed invention:

- to provide a method of creating solder bumps while improving the solder bump height without changing the size of the Under
- Bump Metal
- to provide a method of creating solder bumps that allows for increasing the bump height for applications where the solder
- bump is created over a small contact pad
- to provide a method of creating solder bumps that allows for improved control over the height of the solder bump, and
- to provide a method of creating an improved solder bump that does not add to the cost of creating a solder bump.

As to claims 11 and 25, the rejection of these claims is considered moot since these claims have been cancelled.

As to claims 2 and 16, these claims provide important detail of implementation to the specification of the claimed invention. Huang does not, contrary to examiner's assertions, discuss a grey-tome mask in col. 4, line 40 of the Huang specification. Claims 2 and 16 specify that photoresist is preferred to be used as a patterning material.

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As to claims 3-4, 17-18, these claims provide important detail of implementation to the specification of the claimed invention. Huang does not, contrary to examiner's assertions, discuss the use of chromium, gold, and copper relating to Fig. 7 or in col. 1, lines 45-47, 58-59. These latter lines discuss prior art issues and therefore do not relate to the Huang invention. Huang provides for the use of titanium (layer 340a) copper (layer 340b), nickel-vanadium (layer 340c) and copper (layer 340d).

As to claims 5, 19, these claims provide for additional layers of passivation in order to assure optimum protection of the created device. Huang does not, contrary to examiner's assertions, discuss multiple layers of passivation but highlights, in this referred to text, to the various materials that can be used for a (that is one) layer of passivation. This does not comprise applying multiple layers of passivation in order to create a compound layer of passivation, as provided by the claimed invention.

As to claims 6 and 20, the same comments apply as made supra with respect to claims 5 and 19. The claimed invention applies multiple layers of passivation material in order to

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create a superior layer of passivation, Huang does not provide for this.

As to claims 7 and 21, these claims provide for additional interconnect capabilities of the created solder bump of the claimed invention. Huang does not, contrary to examiner's assertions, provide for or discuss further interconnections to the bump provided by Huang, this also applies to the descriptive text relating to Fig. 7 that is provided by Huang.

As to claims 8 and 22, the text that is referred to by Examiner, that is col. 1, lines 30-42, discusses prior art and therefore does not relate to the Huang invention. Claims 8 and 22 provide for additional support surfaces over which the solder bump of the claimed invention can be provided. Huang does not, contrary to examiner's assertions, provide for or discuss such semiconductor support surfaces.

As to claims 9 and 23, Huang does not, contrary to Examiner's assertions, provide for or discuss the application of solder flux in the text (col. 4, lines 39-45) referred to by Examiner. This is a separate steps of creating a solder bump, since it provides for superior flow of the created layer of

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solder material, this application is of importance in creating a solder bump of low tensile stress and high quality.

As to claims 13 and 27, Huang does not, contrary to Examiner's assertions, provide for or discuss the application of sputter clean in the text (col. 4, line 36) referred to by Examiner. Huang highlights sputtering to deposit nickel-vanadium (layer 340c) and copper (layer 340d) on the titanium layer (layer 340a). Huang does not provide for sputter cleaning of the exposed contact pad, this is a step that can be very effective in creating a clean deposition surface before depositing a layer of UBM, Huang does not provide for this.

As to claims 14, 28, Huang does not provide for the application of a seed layer over the surface of the contact pad. Huang provides for a layer 340a of titanium, which is removed from the surface of the contact pad, a layer 340b as a barrier layer, a layer 340c of nickel-vanadium and a layer 340d of copper which functions as a seed layer but which is not deposited directly over the contact pad, as is shown in the cross section of Fig. 7 of Huang.

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In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 1-11, 13-25, 27-28 under 35 U.S.C. 102(e) as being anticipated by Huang (U.S. Patent 6,452,270 B1), be withdrawn.

Claim rejections - 35 U.S.C. § 103

Reconsideration of the rejection of claims 12 and 26 under 35 U.S.C. 103(a) as being unpatentable over Huang (U.S. Patent 6,452,270 B1) is respectfully requested based on the following.

The relative merits of the Huang invention with respect to the claimed invention have been highlighted supra and are enclosed at this time by reference as being equally applicable to claims 12 and 26.

Claims 12 and 26 provide additional and required detail relating to the grey tone mask that is provided by the claimed invention for the creation of a solder bump.

Huang does not address nor provide for any aspects of creating a layer of photoresist for purposes of creating a layer

of solder material having a particular profile, as highlighted in Figs. 7-10 of the claimed invention. Basic and of significant importance to the creation of this solder bump of the claims invention is the use of the exposure mask, as shown in the cross section of Fig. 7 of the claimed invention. For this exposure mask, specific requirements of design must be specified, this specification is provided by claims 12 and 26.

For instance, Huang does not provide for, as specified in amended claim 12 of the claimed invention, a grey-tone mask that comprises:

- at least one pattern of two concentric patterns of opaque material, the at least one pattern of two concentric patterns comprising a first pattern and a second pattern
- the first pattern of the two concentric patterns of opaque material being a pattern that surrounds the second pattern, the first pattern having a first thickness
- the second pattern of the two concentric patterns surrounding a transparent surface area of the grey-tone mask, the transparent surface area being aligned with the at least one contact pad provided on the substrate, the second pattern having a second thickness, and

- the first thickness being larger than the second thickness.

Because Huang does not provide for creating the layer of solder material overlying the contact pad and having specific design parameters within the context of the design parameters of the solder bump of the invention, Huang et al. does not provide for the essential advantages that are provided by the claimed invention, as quoted above and as repeated at this time in view of their importance in comparing Huang with the claimed invention, as follows:

- to provide a method of creating solder bumps while improving the solder bump height without changing the size of the Under Bump Metal
- to provide a method of creating solder bumps that allows for increasing the bump height for applications where the solder bump is created over a small contact pad
- to provide a method of creating solder bumps that allows for improved control over the height of the solder bump, and
- to provide a method of creating an improved solder bump that does not add to the cost of creating a solder bump.

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In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 12 and 26 under 35 U.S.C. 103(a) as being unpatentable over Huang (U.S. Patent 6,452,270 B1), be withdrawn.

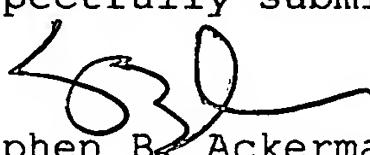
The prior art made of record and not relied upon that is considered pertinent to Applicant's disclosure, that is Lin (U.S. Patent 6,426,556 B1) and Lin et al. (U.S. Patent 6,426,281 B1) have been examined and have been found to be of general interest to the invention.

Other Considerations

New independent claim 29 and new dependent claims 30-36 have been written as a result of this office action.

It is requested that, should Examiner not find the claims to be allowable, to call the undersigned Attorney at the Examiner's convenience at 845-452-5863 in order to overcome any problems preventing allowance of the claims.

Respectfully submitted,


Stephen B. Ackerman
Reg. No 37,761
Tel. (845) 452-5863